

INTEGRATING THE EVERYDAY-LIFE CONTEXT IN SUBJECTIVE VIDEO QUALITY EXPERIMENTS

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ABSTRACT

Controlled subjective quality experiments are a well-known method to make decisions on the improvement of Quality of Service (QoS) of video streams. Recently it became clear that from a point of view of the consumer or user, the Quality of Experience (QoE) is more relevant and can influence the optimal QoS as determined in a lab-setting. The measurement of QoS parameters in a lab-setting does not take into account the specific context of the practice that is under examination (e.g. watching video content).

In this paper we discuss a method of contextualized subjective quality experiments as we applied in different research projects in complement to the standardized lab-experiments. The strength of this method is that video and audio quality is assessed in the real-life context of the user, i.e. his or her natural habitat in which the behavior or practice normally takes place. We provide an overview of how we applied the contextualized research approach in two cases. Next we discuss the method's strengths and weaknesses and suggest a refinement of the methodology.

Index Terms— Quality of Experience, subjective experiments, context, everyday life, audiovisual quality

1. INTRODUCTION

Standardized subjective (audio)visual quality assessment methodologies, as defined in International Telecommunication Union (ITU)-T Recommendation P.910 [1] and ITU-R Recommendation BT.500-12 [2], describe in detail how subjective experiments should be set up and conducted. Amongst others, the methodologies specify the allowed room illumination, display brightness and contrast, and viewing distance between the viewer and the screen. During subjective quality assessment, several video sequences need to be evaluated and rated. The standardized assessment methodologies specify several presentation structures, which can be used to show the different sequences to the subjects. Limitations are also imposed on the duration of the individual video sequences and on the overall experiment duration. In general, video sequences with duration of 10 seconds are used and the experiment duration should be limited to 30 minutes [1, 2]. The latter is mainly enforced in order to avoid viewer fatigue. The results of these experiments are commonly used to

quantify the effects of video encoding and transmission on perceived quality of end-users.

At the same time, different attempts are being made to determine parameters to measure the quality of experience (QoE) both from a technical and from a user perspective [3]. The definition of QoE differs slightly depending on the perspective. Within the ITU, we find a more technical definition of QoE: “*The overall acceptability of an application or service, as perceived subjectively by the end-user*” [4]. This is a rather broad definition, which only states that QoE involves acceptability as perceived by the user, which is also the case in the standardized lab-tests as described above. However, they do add the following two notes: 1) *Quality of Experience includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc)* and 2) *Overall acceptability may be influenced by user expectations and context*” [4].

The latter remark incorporates a broader definition of the concept of QoE, as it also takes into account the user expectations and context of the experience. This is precisely what we try to incorporate in our contextualized research method, as we take into account the experience of the evaluated service or practice as a whole, in its natural context or setting, from the perspective of the user.

2. INTEGRATING CONTEXT

Although subjective lab experiments have several advantages (e.g. optimal control of parameters and comparability) there often is nearly no relationship between the situation or context of the test in a controlled lab-setting and the actual situation of the investigated service or practice in real-life. As we have described above, in lab-tests to evaluate audiovisual quality of video streaming, the user is brought to a lab setting and is asked to judge short sequences on quality. The user is thus biased as he is primarily focusing on the quality and determining what the best quality is. As all participants judge the same sequences in the same circumstances, this provides optimal comparability of results. However, the specific context of the experience itself (watching meaningful audiovisual content in a lean-back manner) and of the situation (user's own devices and related settings) and practices, are not taken into account [5].

Only few attempts have been made to integrate the actual user context in the subjective test-design. Strohmeier et.al. [6]

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for example conducted an experiment based on an Open Profiling of Quality approach to evaluate the overall quality of mobile 3D videos in both a controlled lab-setting and in a café. They chose the café as setting, because this was identified as one of the most common contexts to watch mobile 3DTV. In both settings of the experiment (lab and café), the users were asked to judge the quality of the same sequences, presented as six short fragments on the same type of device. The only difference was the characteristics of the setting of the test; quiet and calm in the lab, with the users watching and evaluating the content in a straight position versus noisy in the café, with the respondents watching the content in a lean-back way in the meantime enjoying a cup of tea. They found similar results, only the sensitivity towards crosstalk was more pronounced in the café context. This example can be seen as a first attempt to include context in the design of the subjective evaluation, but as we note, this is not the actual real-life context of the respondents. The respondents are still asked to come to the setting of the test and are asked to do a quality evaluation of short fragments on the device they receive for the test. As such, only the location is taken outside a lab setting, but it still remains an artificial setting. This because watching 3D content is not an actual practice the respondents are familiar with and the respondents are not using their own device in their own preferred setting.

Jumisko-Pyykkö and Hanuksela [7] conducted real-life user experiments on mobile television viewing. They asked respondents to watch mobile television fragments in three use contexts: waiting in a train station, taking a bus and waiting in a café. The respondents watched fragments of 60 seconds and were asked to rate the quality after each fragment. Although the selected use contexts are natural situations in which watching mobile television takes place, it is not clear whether watching mobile television was an actual real-life practice for the respondents.

In the following paragraphs, we will discuss two projects in which we did incorporate the actual everyday life context of the respondents in the conducted experiments. A first experiment is on the use of full-length movies, the second experiment is on an online communal TV streaming service.

2.1. Case 1: Full-length movie experiment



Figure 1: watching movie in natural context

2.1.1. Description of the experiment

In a first research project, we conducted an experiment to assess the QoE of IPTV and Video-on-Demand (VoD) services with 36 households (91 subjects) [5, 8]. They were asked to watch a full-length movie on their preferred device (TV, Computer, Portable device) and in their preferred social context (alone, with partner, with the entire family). This test was part

of a wider social-scientific qualitative user research set-up, investigating practices, motivations, sense making and trends regarding the use of video-in-the home in a broad definition. The movie (“Bicentennial Man”) was provided on a DVD-disk and they were not aware of the fact that degradations were inserted. The theme of the movie fitted in the research scope of future media and the respondents were told that the interview would be about the movie. In total six degradations, each 8 seconds long, were inserted in the entire movie. There were four different versions of the movie: (1) a version containing fragments in half frame rate (viewer experiences jerkiness); (2) a version with SNR quality impairments (viewer experiences blockiness); (3) a custom version with a mix of half rate and quality impairments and (4) a version simulating random packet loss with a total freeze of the last correctly decoded image, representing typical set-topbox behavior when no scaling is available. Impairments were inserted in 6 fragments, each with different characteristics.

Scene	Description
Flickering wood fire	Dialogue with flickering wood fire in the forefront of the scene. Dark scene with low motion but rapid changing colors due to the fireplace.
Scene in church	Medium speed vertical panning, camera zooms in on actor, no dialogue, only tragic music
Overview marketplace	Diagonal panning towards overview scene of a marketplace in bright daylight with people walking around. No dialogue, only voice over that tells a story.
Hospital scene	Scene in hospital, very white, people passing by, no dialogue.
Scene in lab	Scene in lab, no dialogue, only noise of robot moving a suitcase.
Discussion in close-up	Intimate conversation between the two main characters in the movie. Close-up on their faces.

Figure 2: selected movie scenes

The respondents watched the entire movie and only afterwards were asked to complete a short survey asking if they noticed any impairments and in which fragments (description of scene). They were interviewed by a researcher in their home the day after they watched the full movie. In this interview, the entire experience of watching the particular movie was discussed (Did they like the movie? How did they watch it? Why on this particular device? Which errors did they notice?), but also the wider context was discussed (e.g. which types of content do they consume on which devices, what other experience with content in different qualities do they have, what is their attitude towards different video qualities on different devices, what is their willingness to pay for video etc.). The aim of this discussion was to understand the video consumption practices of the household and how they experience the specific practice of watching a movie at home.

Next, the different ‘errors’ they encountered were discussed based on the questionnaire. The scenes in which they

did not note an ‘error’ while watching the movie, were shown in the quality as they had seen it. In the next step, the different scenes with impairments were shown to them and for each impairment, alternatives were presented. These alternatives were also presented on their own device (on which they originally watched the movie). The respondents expressed their preference for each scene (half rate, quality or random) and motivated their choice for a specific fragment.

2.1.2. Results of the experiment

The following graphs show the % of respondents that notified the SNR or temporal downscaling (figure 3) and the number of respondents that prefer a certain solution for each scene (figure 4).

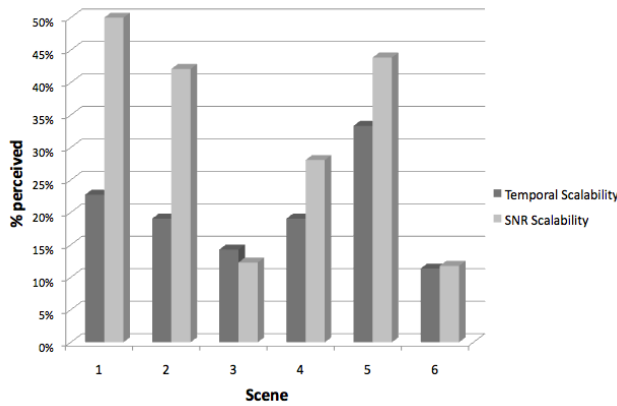


Figure 3: perceived impairments (% of respondents)

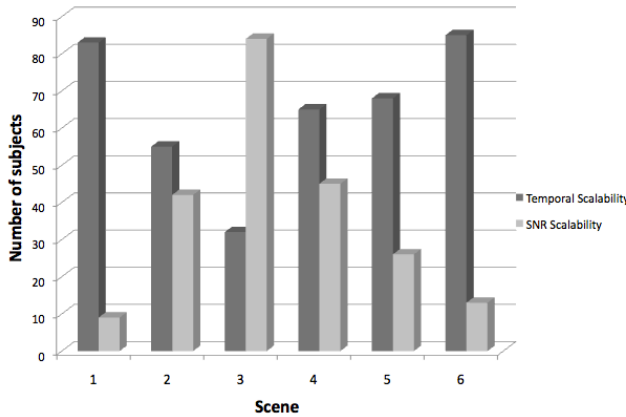


Figure 4: preferred impairments (number of respondents)

When the respondents discuss how they noticed the errors and why they prefer a certain solution, we noted that the type of scene and its specific characteristics are important. In the first scene for example (flickering wood fire), temporal scalability was clearly the preferred solution. The flickering induced by the half frame rate version was attributed to the flickering of the wood fire. In this scene, the blockiness was noted by more respondents and was found more disturbing. In the third scene (market place overview), the lack of a clear focal point resulted in very low perception of the impairments. In scene 5 (the lab-scene), both impairments were noted which is linked to the background of the scene as this has different color-

combinations. The blockiness was noted in this scene because of the fact that it made the image fuzzy; the faltering image caused by the half frame rate was found less disturbing, because it was in line with the natural movements of the robot in the scene. This explains the clear preference for the half rate solution in this scene. The motivation of the respondents that did prefer the quality solution (SNR scalability) (N=23) is that they prefer a natural and fluent flow of the movie over perfect image quality. In the last scene, (the discussion in close-up), half frame rate was preferred, but only few people noted the impairments, because it was a romantic scene and they were in the flow of the movie. This flow-experience or immersion is extremely important in the context of consuming video content like a movie or a TV-series. Once people are indulged in the story, they often do not note minor impairments, because they are focusing on the content (the developments in the movie). Only when an impairment disturbs this immersion and takes the viewer out of the flow-experience, it is perceived as really annoying and is therefore found unacceptable. This was always the case for the random packet loss, in which the viewer experienced a total freezing of the image (this was therefore not included in the further analysis).

By questioning these respondents in the natural context for the use case (watching a full-length movie at home), we were able to detect some other specific context-elements influencing the results of the subjective experiments (besides the flow-experience and the relation with the specific characteristics of the content). First we noted that those respondents that did note impairments often ascribed this to their own hardware that was failing (e.g. old TV, slow computer or Internet connection) and not to the content carrier (DVD) as such. Second the preferred device (TV or PC) also has different related quality expectations. People expect an impeccable quality of content displayed on their TV-set, specifically when it concerns digital television. On a computer they are used to watching content in inferior quality (e.g. on YouTube or other streaming sites) and therefore have lower quality expectations. This is also noticeable when we compare the percentage of noted errors for each device. The SNR quality impairments were noted foremost on TV, while the temporal scalability impairments were noted foremost on the computer. A possible explanation is the fact that respondents are used to blockiness while consuming video content on PC. On TV they expect a better quality compared to the PC screen and the larger screen size of the TV, also makes that blockiness is perceived as being more noticeable.

In the discussion it also became clear that the acceptance of inferior quality is linked closely to the type and source of content, for example a short user-generated movie on YouTube in very bad quality can have massive user attention and appreciation if it concerns footage of a unique event that is not available in better quality. But also online pirate versions of movies taped illegal in movie theatres in an inferior quality are consumed online because of the desirability of the content.

2.1.3. Complementarities with lab-results

The results of this test were placed next to the results of a subjective test applying the Single Stimulus ACR method as described in ITU-R Recommendation BT.500-11. For this

experiment, the impaired video fragments were taken from the movies, trimmed to a duration of 10 seconds, and shown to a number of non-expert users in a standard lab environment.

The main goal was to assess the influence of the primary focus, which was different in both settings. During real-life QoE assessment, subjects were mainly concentrated on content whereas in this experiment, the test subjects were primarily focused on visual quality evaluation.

Our results showed a clear difference in impairment visibility and tolerance. In general, impairments are easier detected during the controlled lab experiment. Impairment tolerance is influenced by immersion. During the interview, subjects indicated that they are more tolerant towards impairments that do not break the natural flow of the movie. As such, blockiness impairments are often rated less disturbing compared to frame rate reductions. However, during in-lab experiments, blockiness impairments were rated worse quality compared to a reduced frame rate.

This implies that primary focus and immersion are important factors to consider during quality assessment and also the other identified contextualized factors (device, quality expectations) should be taken into account. Although recency effects do occur when using short fragments (10s) [9], we found no evidence of this in the real-life tests with long sequences.

2.2. Case 2: Communal TV streaming service

2.2.1. Description of the experiment

Our second experiment was on the streaming service of the Belgian municipality Koksijde. From November 2010 on, the monthly town council is streamed live and is also available on-demand afterwards (koksijdetv.be). Koksijde is the first Belgian municipality that offers this service, which made it an interesting case. In a first phase of the research on this case, we launched a survey asking users of the service to give their opinion on the service and make suggestions for improvements. From this survey (N=42) it became clear that overall the users were satisfied with the offered service, but that specifically the sound of the service needed improvement. Therefore we decided to focus on the audio in the second phase.

In this qualitative user research phase, 12 users of the service were interviewed. This interview consisted of three parts: 1) we discussed the use of and the respondents' experience with the service; 2) we asked them to show how they normally used the service and discussed some fragments; 3) we did a double stimulus experiment [2] with focus on the audio. For this audio experiment, a fragment of 47 seconds was selected. The respondents first viewed the fragment in the setting as they are used to (i.e. with or without earplugs, with or without external boxes) and rated the original fragment using a 5-grade ACR scale. Then they compared 10 sequences of the same fragment with the original fragment. The 10 sequences contained the following adaptations:

A	Original fragment (mono)
B	Stereo
C	Volume half compared to a
D	Volume double compared to a

E	Stereo + volume half compared to a
F	Stereo + volume double compared to a
G	Half sampling rate
H	1/4 th sampling rate
I	1/4 th sampling rate + volume double compared to a
J	Half sampling rate + stereo
K	Half sampling rate + stereo + double volume than a

Table 1: audio adaptations

The respondents selected their preferred fragment and motivated their preference. They also gave a quality rating to each of the 10 fragments. At the end of the first selection, the fragments with the same score were rated against each other in order to make a ranked list. The interview duration was one hour. Five of the interviews were conducted in respondents' homes on their own device where they normally use the service. These are the actual real-life tests as also applied in the first discussed case. Seven of the interviews took place in the town hall of Koksijde, on the researcher's computer (Macbook Pro). This is a more artificial setting, as the respondents all used the same computer with the same sound settings. The difference with the lab-tests and the tests as described in [6, 7], is that the respondents were actual users of the streaming service in their everyday lives and watching the service was as such a real-life practice.

2.2.2. Results of the experiment

In this research we clearly noted the importance of the value of the content as mentioned above. In this case it concerns the Town council, content that is not available anywhere else. The audiovisual quality of the streaming service is certainly not perfect, but the respondents are primary satisfied with the existence of the service as it gives them the opportunity to watch the Town council online (live and on-demand). In discussing their experience with the service, the identified points of improvement are firstly related to the presentation of the information (e.g. adding visual information of plans or objects that are being discussed) and start the meeting in time. The audiovisual quality only comes second. The results of the double stimulus experiment were surprising as the preference differed severely even for the 7 tests conducted in the town hall on the same device (of which we expected more similar results, as the device, audio setting and test-environment were the same). All respondents rated the basic fragment (a) with a score 4. When we consider the top-scoring fragments in the respondents' top rankings, we see that 7 respondents put fragment d (volume double compared to original) on the first place. Three respondents prefer k (half sampling rate + stereo + double volume) and two respondents prefer j (half sampling rate + double volume). The respondents that chose d (MOS 4.1) explained the preference for this fragment as a logic choice. The original fragment is rather quiet; the respondents have to turn on their volume almost to the maximum. Their rationale is that if the volume is twice as loud, they can turn their volume down to the appropriate sound for them. The fact that the original fragment as well as fragment d was in mono was not something that bothered them, even not the respondents that used a headphone. The preference for k was motivated as this fragment being 'warm, natural and

clear'. The preference for j by two respondents was rather remarkable, as only 3 respondents in total preferred j over the basis fragment a. 4 others heard no difference between a and j and the five remaining respondents preferred a for this fragment, as they found j sounding 'dull' and 'lispings'. Fragment g (half rate) has a MOS of 3.7, implying that half sampling rate has no significant influence on the QoE. As could be expected, fragments h (1/4th sampling rate) and i (1/4th sampling rate + double volume) received the lowest preference and average MOS (1.9 and 2.1). Fragment h was preferred by none of the respondents, fragment i was preferred by two, as it was louder than the original scene. Comments about fragment h and i were that it was unnatural, not sounded like the natural voice of the council member and that it was too dull. As such, we can identify two broad aspects influencing the preference. A first factor is the sound level. Two respondents consequently chose the loudest fragment. The other aspect is the naturalness of the sound. Here we see that respondents chose for the clearest sound, leaning closest to the original voice of the council member in the scene, which they know from their experience with the service.

3. EVALUATION OF THE METHODOLOGY

3.1. Strengths

Advantages of the applied method and research setting are that the tests occur in the natural everyday life context of the specific practice (e.g. watching a movie at home, watching a community council meeting online on the home computer or in the town hall). The artificial setting of a lab setting is as such avoided, as well as the typical short sequences that are used in these tests. Particularly for the full-length movies, the entire movie was watched and judged afterwards in its natural context, offering the viewer the opportunity to watch the movie in a "flow-experience", as is typical for watching a movie when one is "into the story". This was also demonstrated in the results, as those impairments that took the respondents out of the story were found annoying, while others were often not noticed or not found disturbing. In the example of the streaming communal service, we did conduct a quality evaluation, but with respondents who actually used the service and preferably on their own device.

By assessing quality in a real-life environment, we are able to influence the primary focus of the respondents. In the case of using full-length DVD movies, primary focus shifted from active visual quality evaluation to watching and enjoying the actual content of the movie. In the case of the communal service, respondents were aware of the evaluation, but it concerned a natural practice to them (watching the town council). This leads to a more natural evaluation of Quality of Experience in relation to video quality.

Important is that QoE is not only attributed to the video quality per se, but also to the devices and infrastructure that is used and the content. It is the total product ecology in context determining this interpretation. This helps us to better understand QoE and we can learn about the strategies of solving difficulties with an insufficient QoE. As we have seen, this does not always lead to the right technical source of the

problem (e.g. attributing problems to slow internet connection, old TV etc.).

3.2. Weaknesses

Of course the applied methodology also has some weaknesses. In the case of the full-length movies, the natural context implied that there was no researcher present to observe the practice of watching the full movie. The respondents were asked to complete a questionnaire after the movie, but we could not control whether they opened the survey before the end of the movie or not. Furthermore, if people fast-forwarded certain parts of the movie, because they have already seen it or did not like the story, we could not control this either.

In some cases additional impairments took place due to the hardware of the respondents. This is something that could not be anticipated in this setting.

The fact that the respondents consume the content for research purposes might influence their level of attentiveness during the activity. Because it is part of a research project, one might look more attentive than they would in other cases, or because it was a movie they had to see and might not like, they could watch it less attentively. Another element is the comparability and interpretation of the test results. In the next section we will look into aspects to refine the presented methodology and our future plans for contextualized subjective tests in other domains.

4. DISCUSSION

In this paper we discussed a new way of integrating the everyday life context into subjective quality tests. In the experiment with the full-length movies, this test was conducted in addition to lab-tests with the same impairments. In the streaming experiment in Koksijde, a double stimulus experiment was integrated in the respondents' natural environment. In both experiments we found several contextual factors influencing both the error tolerance and the preference for certain impairments over others.

In the evaluation of the methodology, we identified some other elements for improvement. As we have seen in the full-length movie experiment, the fact that there was no researcher present during the experiment means there is less control over the experiment. This could be overcome by a participating observation, in which the researcher is present to observe. On the other hand, this might influence the natural setting in a negative way. A second element that might need refinement is the objective measurement of certain parameters. In a lab setting, certain parameters are fixed (e.g. lighting, distance to screen, screen size). In our experiments we could measure these parameters as well and take them into account in our statistical analysis.

In two other projects, we will use the real-life environment as a test environment by integrating these measurements of different factors that are usually controlled in a lab setting (e.g. distance to screen, lighting) and thus focus on refining this real-life methodology. One project is related to the domain of entertainment, the other one is in the domain of health. We want to show with these two additional examples the broader

range of possibilities to include a real-life methodology in different extents in different contexts.

A first context is the movie theatre. Also in a more public context (e.g; concerts, movie theatre) it is important to think about researching the contextual influence on the QoE. When making a new projector or screen to be used in a movie theatre, traditional tests focus on the ideal positions in the theatre to evaluate the quality of experience in a homogeneous way. But if you want to know for example the threshold of your minimal needed QoS, it will not be sufficient to focus only on the people in the middle row. Going to the movies is a total experience, including for some eating popcorn and others being annoyed by people eating it. It is a combination effect of reason to go there, which seat you got, which content is played that could make a difference in acceptance of a certain level of QoS. The challenge is to think about new ways to capture all this different aspects and look for interacting patterns to understand better the QoE of a whole theatre. Using mobile phones to question is a path we are researching to do the evaluation in a less obtrusive way than with paper and pencil, although we know that using your phone during a movie is not a natural practice at all, on the contrary.

But also in professional context, taking contextual influence is important. For example, within the health domain variations in QoS go in direct interaction with the main task at hand: providing healthcare. Take for instance the role of a surgeon and that of a circulation nurse during an operation. The role you have will give another experience of the needed video quality of an endoscopic surgery, just because of the different tasks at hand for the different roles. Therefore it is important to make deliberate choices on the role characteristics of the participating evaluators (homogeneity-heterogeneity of the group). Next to perception of quality loss of video for example, perceptions of patient safety and efficiency are also important components to look at. Going into the context of the participant has an extra advantage: to get some time of types of users highly in demand, e.g surgeons, to participate in your tests, but at the other hand ethical procedures can delay your test and should be planned well in advance.

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